Journal of Quantitative Spectroscopy & Radiative Transfer

List of Contents and Author Index
Volume 60, 1998

PERGAMON

JOURNAL OF QUANTITATIVE SPECTROSCOPY & RADIATIVE TRANSFER

Editor: Professor P. Varanasi, *149 Dana Hall, Marine Sciences Research Center, State University of New York, Stony Brook, NY 11794-5000, U.S.A. E-mail:* pvaranasi@ccmail.sunysb.edu

Advisory Committee: R. M. Goody (U.S.A.), H. R. Griem (U.S.A.), J. W. Hovenier (The Netherlands), J. LeNoble (France), R. W. Nicholls (Canada), G. C. Pomraning (U.S.A.), W. Whaling (U.S.A.), and W. L. Wiese (U.S.A.)

Associate Editors

Term ending 31 December 1998

T. Ackerman, *Dept. of Meteorology, Pennsylvania State Univ., 503 Walker Building, University Park, PA 16802, U.S.A.*

G. Birnbuum, *National Institute of Standards and Technology, Materials Division, Bldg 223, Rm 344, Gaithersburg, MD 20899, U.S.A.*

J. Cooper, *Joint Institute for Lab Astrophysics, Univ. of Colorado, Boulder, CO 80309, U.S.A.*

R. G. Ellingson, *Dept of Meteorology, Univ. of Maryland, College Park, MD 20742, U.S.A.*

R. K. Hanson, *High Temperature Gas-dynamics Lab., Dept of Mechanical Engineering, Stanford Univ., Stanford, CA 94305, U.S.A.*

J. E. Harries, *Space and Atmospheric Physics Group, The Blackett Lab., Imperial College, London SW7 2BZ, England*

V. V. Ivanov, *Astronomy Dept, Bibliotechnaya Pl. 2, Stary Peterhof, 198904 St Petersburg, Russia*

K. Lumme, *Observatory, P. O. Box 14, Tahtitornimaki, FIN-00014, Univ. of Helsinki, Finland*

R. D. May, *Jet Propulsion Lab., 4800 Oak Grove Drive, Pasadena, CA 91103, U.S.A.*

C. P. Rinsland, *NASA-Langley Research Center, Mail Stop 410A, Hampton, VA 23665-5225, U.S.A.*

L. S. Rothman, *Phillips Lab, Geophysics Directorate, Hanscom AFB, MA 01731-5000, U.S.A.*

K. Stamnes, *Geophysical Institute, Univ. of Alaska, Fairbanks, P.O. Box 757320, Fairbanks, AK 99775-7320, U.S.A.*

W. Wiscombe, *Climate and Radiation Branch, NASA-Goddard Space Flight Center, Mail Code 913, Greenbelt, MD 20771, U.S.A.*

R. Zander, *Inst. of Astrophysics, Univ. of Liege, 5 Avenue de Cointe, B-4000, Liege-Cointe, Belgium*

Term ending 31 December 1999

A. Barbe, *Groupe de Spectrométrie Moléculaire et Atmosphérique, Faculté des Sciences, BP 347-51062 Reims Cedex, France*

K. V. Chance, *Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, U.S.A.*

A. Chedin, *ARA/Lab de Meteorologie Dynamique du CNRS, Ecole Polytechnique, 91128 Palaiseau Cedex, France*

S. A. Clough, *Atmospheric and Environmental Research Inc., 840 Memorial Drive, Cambridge, MA 02139, U.S.A.*

A. L. Crosbie, *Thermal Radiative Transfer Group, Dept of Mechanical and Aerospace Engineering, Univ. of Missouri-Rolla, Rolla, MO 65401, U.S.A.*

J. Davis, *Plasma Dynamics Branch, Naval Research Lab., Washington, DC 20375, U.S.A.*

H. Fischer, *Inst. für Meteorologie und Klimaforschung, Forschungszentrum Univ. Karlsruhe, P.O. Box 3640, 76021 Karlsruhe, Germany*

A. Goldman, *Dept of Physics, Space Science Lab., Rm 316, Univ. of Denver, 2112 E. Wesley Street, Denver, CO 80208, U.S.A.*

R. W. Lee, *Dept of Physics, Univ. of California, Berkeley, CA 94720-7300, U.S.A.*

K. N. Liou, *Dept Atmospheric Sciences, Univ. of California, Los Angeles, 405 Hilgard Ave., Los Angeles, CA 90095, U.S.A.*

C. E. Siewert, *Dept of Mathematics, North Carolina State Univ., Raleigh, NC 27695-8205, U.S.A.*

W. L. Smith, *CIMSS, Univ. of Wisconsin, 1225 West Dayton St, Madison, WI 53706, U.S.A.*

F. W. Taylor, *Dept of Physics, Atmospheric, Oceanic & Planetary Physics, Univ. of Oxford, Parks Road, Oxford OX1 3PU, England*

Term ending 31 December 2000

J. Ballard, *Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshore OX11 0QX, England*

R. Beer, *M/S 183-301, Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109-8099, U.S.A.*

J.-M. Flaud, *Laboratoire de Photophysique Moléculaire, Bâtment 213, Université de Paris-Sud, 91405 Orsay Cedex, France*

N. Konjević, *Faculty of Physics, University of Belgrade, Studentski TRG 12, P. O. Box 550, 1101 Belgrade, Yugoslavia*

J. E. Lawler, *Department of Physics, University of Wisconsin-Madison, 1150 University Avenue, Madison, WI 53706, U.S.A.*

B. R. Lewis, *Research School of Physical Sciences, Australian National University, Canberra, Australia*

M. I. Mishchenko, *NASA-Goddard Institute for Space Studies, 2880 Broadway, New York, NY 10025, U.S.A.*

E. Oks, *206 Allison Lab., Department of Physics, Auburn University, Auburn, AL 36849-5311, U.S.A.*

C. M. R. Platt, *Department of Atmospheric Science, Colarado State University, Fort Collins, CO 80523-1371, U.S.A.*

T. Viik, *Tartu Observatory, Töravere, EE 2444 Tartumaa, Estonia*

E. G. Yanovitskij, *Laboratory for Radiative Transfer Theory, The Main Astronomical Observatory, Ukranian Academy of Sciences, 252127 Kiev-127, Goloseevo, Ukraine*

Founding Editor: Professor S. S. Penner, *UCSD, La Jolla, CA 92093-0310, U.S.A.*

Author Service Department: For queries relating to the general submission of articles (including electronic text and artwork) and the status of accepted manuscripts, please contact the Author Service Department: *E-mail*: authors@elsevier.co.uk; *Fax*: +44(0)1865 843905; *Tel.*: +44(0)1865 843900.

Publishing Office: Elsevier Science Ltd, Bampfylde Street, Exeter EX1 2AH, England [*Tel.*: Exeter (01392) 251558; *Fax*: (01392) 425370].

Advertising Office: Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, England [*Tel.*: Oxford (01865) 843000; *Fax*: (01865) 843010].

Frequency: Published Monthly—Two volumes per annum. Copyright © 1998 Elsevier Science Ltd

Annual Institutional Subscription Rates 1998: Europe, The CIS and Japan, NLG 4567.00; all other countries US$2625.00. Associated Personal Subscription rates are available on request for those whose institutions are library subscribers. Dutch Guilders prices exclude VAT. Non-VAT registered customers in the European Community will be charged the appropriate VAT in addition to the price listed. Prices include postage and insurance and are subject to change without notice.

Any enquiries relating to subscriptions should be sent to:

The Americas: Elsevier Science Customer Support Department, P.O. Box 945, New York, NY 10010, USA [*Tel.*: (+1) 212-633-3730/1-888 4ES-INFO. *Fax*: (+1) 212-633-3680. *Email*: usinfo-f@elsevier.com].

Japan: Elsevier Science Customer Support Department, 9-15 Higashi-Azabu 1-chome, Minato-ku, Tokyo 106, Japan [*Tel.*: (+81) 3-5561-5033. *Fax*: (+81) 3-5561-5047. *Email*: info@elsevier.co.jp].

Asia Pacific (*excluding Japan*): Elsevier Science (Singapore) Pte Ltd, No. 1 Temasek Avenue, 17-01 Millenia Tower, Singapore 039192. [*Tel.*: (+65) 434-3727. *Fax*: (+65) 337-2230. *Email*: asiainfo@elsevier.com.sg].

Rest of the World: Elsevier Science Customer Service Department, P.O. Box 211, 1001 AE Amsterdam, The Netherlands [*Tel.*: (+31) 20-485-3757. *Fax*: (+31) 20-485-3432. *Email*: nlinfo-f@elsevier.nl].

Back Issues: Back issues of all previously published volumes are available direct from Elsevier Science Offices (Oxford and New York). Complete volumes and single issues can be purchased for 1993–1997. Earlier issues are available in high quality photo-duplicated copies as complete volumes only.

PERIODICALS POSTAGE PAID AT RAHWAY, NEW JERSEY. *Journal of Quantitative Spectroscopy & Radiative Transfer* (ISSN: 0022-4073) is published monthly in 2 volumes of 6 issues by Elsevier Science Ltd. The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, U.K. The annual subscription in the USA is $2625.00. *Journal of Quantitative Spectroscopy & Radiative Transfer*, is distributed in the U.S.A. by Mercury Airfreight International Ltd. 365 Blair Road, Avenel, NJ 07001, U.S.A. POSTMASTER: Please send address corrections to *Journal of Quantitative Spectroscopy & Radiative Transfer*, c/o Elsevier Science Regional Sales Office, Customer Support Department, 655 Avenue of the Americas, New York, NY 10010, U.S.A.

List of Contents

NUMBER 1

I. Drira, A. Spielfiedel, S. Edwards and N. Feautrier	1	Theoretical study of the $A^1\Pi$ $X^1\Sigma^+$ and $E^1\Sigma^+ - X^1\Sigma^+$ bands of SiO
Philippe Ben-Abdallah	9	A variational method to inverse the radiative transfer equation: application to thermal sounding of atmospheres of giant planets
C. Y. Robert Wu and F. Z. Chen	17	Temperature-dependent photoabsorption cross sections of H_2S in the 1600–2600 Å region
M. Raineri, J. G. Reyna Almandos, F. Bredice, M. Gallardo, A. G. Trigueiros and S-G. Pettersson	25	Weighted oscillator strengths for Kr III spectrum
F. Schuller	43	Extended impact theory of pressure broadening of spectral lines for van der Waals interaction potentials
Scott A. Meyer, Daniel Bershader and Surendra P. Sharma	53	Resonance broadening measurements of atomic oxygen at 130 nm
M. Korek and H. Kobeissi	69	Explicit pure rotational effect for diatomic molecule in infrared transitions
Thomas M. Goyette, E. A. Cohen and Frank C. De Lucia	77	Pressure broadening of HNO_3 by N_2 and O_2: an intercomparison of results in the millimeter wave region
E. Nisipeanu and P. D. Jones	85	Identification of the effective radiative properties of a hot, thick, porous medium
T. J. Nash, T. W. L. Sanford, C. Deeney, R. B. Spielman, J. Seaman, J. McGurn, D. O. Jobe, R. C. Mock, T. L. Gilliland, J. P. Apruzese and K. G. Whitney	97	High temperature, dense cores in an aluminum wire array z-pinches observed by spatially-resolved spectroscopy
M. A. Ramankutty and A. L. Crosbie	103	Modified discrete-ordinates solution of radiative transfer in three-dimensional rectangular enclosures
Leslie E. Bauman	135	Non-coincident multi-wavelength emission absorption measurements in MHD plasmas

NUMBER 2

Helen E. Brindley and John E. Harries	151	The impact of far i.r. absorption on clear sky greenhouse forcing: sensitivity studies at high spectral resolution

G. C. Pomraning	181	A renormalized equation of transfer for Rayleigh scattering
A. A. Kutepov, O. A. Gusev and **V. P. Ogibalov**	199	Solution of the non-LTE problem for molecular gas in planetary atmospheres: superiority of accelerated lambda iteration
David Riley	221	Time dependent modelling of K-shell emission lines from laser produced plasmas
A. M. Vogelmann, V. Ramanathan, W. C. Conant and **W. E. Hunter**	231	Observational constraints on non-Lorentzian continuum effects in the near-infrared solar spectrum using ARM ARESE data
L. B. Barichello, R. D. M. Garcia and **C. E. Siewert**	247	A spherical-harmonics solution for radiative-transfer problems with reflecting boundaries and internal sources
L. B. Barichello and **C. E. Siewert**	261	The F_N method for spectral-line formation by completely noncoherent scattering
V. V. Rozanov, T. Kurosu, and **J. P. Burrows**	277	Retrieval of atmospheric constituents in the uv-visible: a new quasi-analytical approach for the calculation of weighting functions

NUMBER 3

Light Scattering by Non-Spherical Particles

K. Lumme	v	Preface
Michael Hess, Robert B. A. Koelemeijer and **Piet Stammes**	301	Scattering matrices of imperfect hexagonal ice crystals
Michael I. Mishchenko and **Larry D. Travis**	309	Capabilities and limitations of a current FORTRAN implementation of the T-matrix method for randomly oriented, rotationally symmetric scatterers
Heikki Laitinen and **Kari Lumme**	325	T-matrix method for general star-shaped particles: first results
Tom Rother	335	Generalization of the separation of variables method for non-spherical scattering on dielectric objects
Andreas Macke and **Martin Großklaus**	355	Light scattering by nonspherical raindrops: implications for lidar remote sensing of rainrates
Harald Czekala and **Clemens Simmer**	365	Microwave radiative transfer with nonspherical precipitating hydrometeors
Helene Chepfer, Gerard Brogniez and **Yves Fouquart**	375	Cirrus clouds' microphysical properties deduced from POLDER observations
P. Mazeron and **S. Muller**	391	Surface fields: application to scattering by perfectly conducting particles
Juho-Pertti Jalava, Veli-Matti Taavitsainen, Heikki Haario and **Lars Lamberg**	399	Determination of particle and crystal size distribution from turbidity spectrum of TIO_2 pigments by means of T-matrix
Thomas Wriedt and **Ute Comberg**	411	Comparison of computational scattering methods
Hiroshi Kimura and **Ingrid Mann**	425	Radiation pressure cross section for fluffy aggregates

Kari Lumme and **Jussi Rahola**	439	Comparison of light scattering by stochastically rough spheres, best-fit spheroids and spheres
Yu. Eremin and **N. Orlov**	451	Modeling of light scattering by non-spherical particles based on discrete sources method
Arturo Quirantes and **Angel Delgado**	463	Experimental size determination of spheroidal particles via the T-matrix method
Yu. A. Eremin and **V. I. Ivakhnenko**	475	Modeling of light scattering by non-spherical inhomogeneous particles
J. W. Hovenier and **D. W. Mackowski**	483	Symmetry relations for forward and backward scattering by randomly oriented particles
Brent M. Nebeker, Greg W. Starr and **E. Dan Hirleman**	493	Evaluation of iteration methods used when modeling scattering from features on surfaces using the discrete-dipole approximation

NUMBER 4

C. Boussin, B. L. Lutz, C. De Bergh and **A. Hamdouni**	501	Line intensities and self-broadening coefficients for the $3\nu_2$ band of monodeuterated methane
S. O. Kastner	515	On the expressions for line optical thickness
N. P. Efremov and **N. P. Poluektov**	523	Tomography of atom and ion temperatures in plasmas
Michael Stobbe, Axel Könies, Sibylle Günter and **Jacek Halenka**	531	Shift and width of HeII lines
A. K. Bhatia and **S. O. Kastner**	543	Local doppler-profile escape factors within the cylinder
A. Mirone, F. Gilleron, J. C. Gauthier and **G. Faussurier**	551	Statistical mechanics of average ions in non-local thermodynamic equilibrium plasmas
J. R. Pardo, M. Gérin, C. Prigent, J. Cernicharo, G. Rochard and **P. Brunel**	559	Remote sensing of the mesospheric temperature profile from close-to-nadir observations: discussion about the capabilities of the 57.5–62.5 GHz frequency band and the 118.75 GHz single O_2 line
D. M. O'Brien	573	Monte Carlo integration of the radiative transfer equation in a scattering medium with stochastic reflecting boundary
Xavier Michaut, Jean-Philippe Berger, Peter M. Sinclair and **Hubert Berger**	585	Fitting law for the density shift of $Q(J)$ transitions of H_2 in H_2–X (X: H_2, He, N_2) mixtures
F. M. B. Andersen and **S. Dyrbøl**	593	Modelling radiative heat transfer in fibrous materials: the use of planck mean properties compared to spectral and flux-weighted properties
R. Bruch, U. I. Safronova, A. S. Shlyaptseva, J. Nilsen and **D. Schneider**	605	New comprehensive theoretical analysis of the doubly excited $3\ell n\ell'$ states of sodium-like iron
P. Martel, J. G. Rubiano, J. M. Gil, L. Doreste and **E. Minguez**	623	Analytical expressions for the n-order momenta of charge distribution for ions

Merritt N. Deeter and **K. Franklin Evans** 635 A hybrid Eddington-single scattering radiative transfer model for computing radiances from thermally emitting atmospheres

L. B. Barichello and **C. E. Siewert** 649 A computation of the X and Y functions for a non-grey model with complete frequency redistribution

Note

G. Veres 657 Frequency-averaged opacities for plasmas with arbitrary optical thickness

Corrigendum I

NUMBER 5

HITRAN

Laurence S. Rothman, Aaron Goldman and **Curtis P. Rinsland** 661 Preface

L. S. Rothman, C. P. Rinsland, A. Goldman, S. T. Massie, D. P. Edwards, J.-M. Flaud, A. Perrin, C. Camy-Peyret, V. Dana, J.-Y. Mandin, J. Schroeder, A. McCann, R. R. Gamache, R. B. Wattson, K. Yoshino, K. V. Chance, K. W. Jucks, L. R. Brown, V. Nemtchinov and **P. Varanasi** 665 The HITRAN molecular spectroscopic database and HAWKS (HITRAN Atmospheric WorKStation): 1996 edition

Mark P. Esplin, Richard B. Wattson, Michael L. Hoke and **Laurence S. Rothman** 711 High-temperature spectrum of H_2O in the 720–1400 cm^{-1} region

V. Malathy Devi, D. Chris Benner, Curtis P. Rinsland and **Mary Ann H. Smith** 741 Absolute rovibrational intensities of $^{12}C^{16}O_2$ absorption bands in the 3090–3850 cm^{-1} spectral region

V. Malathy Devi, D. Chris Benner, Mary Ann H. Smith and **Curtis P. Rinsland** 771 Pressure broadening and pressure shift coefficients in the $2\nu_2^0$ and ν_1 bands of $^{16}O^{13}C^{18}O$

S. A. Tashkun, V. I. Perevalov, J.-L. Teffo, L. S. Rothman and **Vl. G. Tyuterev** 785 Global fitting of $^{12}C^{16}O_2$ vibrational–rotational line positions using the effective Hamiltonian approach

C. P. Rinsland, J.-M. Flaud, A. Goldman, A. Perrin, C. Camy-Peyret, M. A. H. Smith, V. Malathy Devi, D. C. Benner, A. Barbe, T. M. Stephen and **F. J. Murcray** 803 Spectroscopic parameters for ozone and its isotopes: current status, prospects for improvement, and the identification of $^{16}O^{16}O^{17}O$ and $^{16}O^{17}O^{16}O$ lines in infrared ground-based and stratospheric solar absorption spectra

V. Malathy Devi, D. Chris Benner, Mary Ann H. Smith and **Curtis P. Rinsland** 815 Self-broadening and self-shift coefficients in the fundamental band of $^{12}C^{16}O$

A. Goldman, L. R. Brown, W. G. Schoenfeld, M. N. Spencer, C. Chackerian Jr., L. P. Giver, H. Dothe, C. P. Rinsland, L. H. Coudert, V. Dana and J.-Y. Mandin 825 Nitric oxide line parameters: review of 1996 HITRAN update and new results

A. Perrin, J.-M. Flaud, A. Goldman, C. Camy-Peyret, W. J. Lafferty, Ph. Arcas and C. P. Rinsland 839 NO_2 and SO_2 line parameters: 1996 HITRAN update and new results

A. Goldman, C. P. Rinsland, A. Perrin and J-M. Flaud 851 HNO_3 line parameters: 1996 HITRAN update and new results

M. T. Coffey, A. Goldman, J. W. Hannigan, W. G. Mankin, W. G. Schoenfeld, C. P. Rinsland, C. Bernardo and D. W. T. Griffith 863 Improved vibration–rotation (0–1) HBr line parameters for validating high resolution infrared atmospheric spectra measurements

A. Goldman, K. V. Chance, M. T. Coffey, J. W. Hannigan, W. G. Mankin and C. P. Rinsland 869 Improved line parameters for the $X^1\Sigma^4$ (0–0) and (0–1) bands of HI

A. Goldman, C. P. Rinsland, J.-M. Flaud and J. Orphal 875 $ClONO_2$: spectroscopic line parameters and cross-sections in 1996 HITRAN

H. M. Pickett, R. I. Poynter, E. A. Cohen, M. L. Delitsky, J. C. Pearson and H. S. P. Müller 883 Submillimeter, millimeter, and microwave spectral line catalog

C. P. Rinsland, M. R. Gunson, P.-H. Wang, R. F. Arduini, B. A. Baum, P. Minnis, A. Goldman, M. C. Abrams, R. Zander, E. Mahieu, R. J. Salawitch, H. A. Michelsen, F. W. Irion and M. J. Newchurch 891 ATMOS/ATLAS 3 infrared profile measurements of trace gases in the November 1994 tropical and subtropical upper troposphere

C. P. Rinsland, M. R. Gunson, P.-H. Wang, R. F. Arduini, B. A. Baum, P. Minnis, A. Goldman, M. C. Abrams, R. Zander, E. Mahieu, R. J. Salawitch, H. A. Michelsen, F. W. Irion and M. J. Newchurch 903 ATMOS/ATLAS 3 infrared profile measurements of clouds in the tropical and subtropical upper troposphere

NUMBER 6

F. Yousefian and M. Lallemand 921 Inverse radiative analysis of high-resolution infrared emission data for temperature and species profiles recoveries in axisymmetric semi-transparent media

M. Kocifaj and J. Lukáč 933 Using the multiple scattering theory for calculation of the radiation fluxes from experimental aerosol data

M. Vountas, V. V. Rozanov and J. P. Burrows 943 Ring effect: impact of rotational Raman scattering on radiative transfer in earth's atmosphere

R. Wehrse, W. von Waldenfels and B. Baschek 963 Differentially moving media with many spectral lines: stochastic approach

M-Y. Allout, J-Y. Mandin, V. Dana, N. Picqué and G. Guelachvili	979	FTS generalized apparatus function
A. M. Polo, J. M. L. Poyato, J. J. Camacho and A. Pardo	989	Intensity study of LIF spectrum for the $B0_u^+ \rightarrow X0_g^+$ system of a tellurium natural sample
S. K. Sharma, Ashim Kumar Roy and D. J. Somerford	1001	New approximate phase functions for scattering of unpolarized light by dielectric particles
H. Aroui, M. Broquier, A. Picard-Bersellini, J. P. Bouanich, M. Chevalier and S. Gherissi	1011	Absorption intensities, pressure-broadening and line mixing parameters of some lines of NH_3 in the ν_4 band
J. P. Burrows, A. Dehn, B. Deters, S. Himmelmann, A. Richter, S. Voigt and J. Orphal	1025	Atmospheric remote-sensing reference data from GOME: Part 1. Temperature-dependent absorption cross-sections of NO_2 in the 231–794 nm range
J. Bergeat and B. Rutily	1033	Auxiliary functions for radiative transfer problems in plane-parallel geometry—II. The semi-infinite medium
D. K. Bronnikov, D. V. Kalinin, V. D. Rusanov, Yu. G. Filimonov, Yu. G. Selivanov and J. C. Hilico	1053	Spectroscopy and non-equilibrium distribution of vibrationally excited methane in a supersonic jet
A. N. Valentyuk	1069	Stochastic radiative transfer in M-component Markovian mixtures
Note		
J. M. Midha and S. C. Gupta	1087	Charge exchange cross sections for multiply charged ions colliding with hydrogen atom
Letter to the Editor		
K. Yoshino, D. L. Huestis and R. W. Nicholls	1091	Comment on the Herzberg continuum